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Status of 'Site' Program Demonstrations

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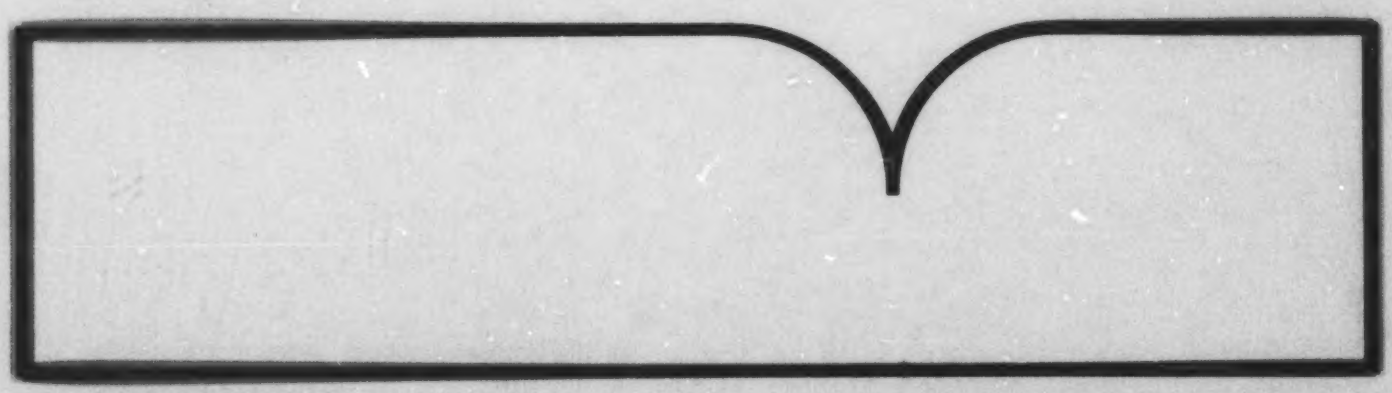

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16. ABSTRACT The U.S. Environmental Protection Agency (EPA) has established a technology research, demonstration and evaluation program to promote the use of innovative technologies for the treatment and destruction of hazardous waste materials. In pursuing this program, EPA has responded to the growing concern over the use of land-based containment technologies and the presence of uncontrolled hazardous waste sites. The Office of Emergency and Remedial Response (OERR), has issued guidance to increase the use of alternative technologies at hazardous waste sites.

In response to the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Office of Research and Development (ORD) and OSWER have established the Superfund Innovative Technology Evaluation (SITE) program to accelerate the development and use of alternative technologies at Superfund sites. The SITE program will provide assurance on performance data and cost information on those technologies. The SITE program staff has now initiated several demonstrations of the first ten technologies selected in 1986 and is progressing in implementing the eleven selected technologies for 1987. At present, the SITE program staff is reviewing the proposals received from the 1988 solicitation.

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STATUS OF "SITE" PROGRAM DEMONSTRATIONS

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ABSTRACT

The U.S. Environmental Protection Agency (EPA) has established a technology research, demonstration and evaluation program to promote the use of innovative technologies for the treatment and destruction of hazardous waste materials. In pursuing this program, EPA has responded to the growing concern over the use of land-based containment technologies and the presence of uncontrolled hazardous waste sites. The Office of Emergency and Remedial Response (OERR), within the Office of Solid Waste and Emergency Response (OSWER), has issued guidance to increase the use of alternative technologies at hazardous waste sites.

In response to the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Office of Research and Development (ORD) and OSWER have established the Superfund Innovative Technology Evaluation (SITE) program to accelerate the development and use of alternative technologies at Superfund sites. The SITE program will provide the opportunity for demonstration of new and innovative technologies, as well as provide assurance on performance data and cost information on those technologies. The SITE program staff has now initiated several demonstrations of the first ten technologies selected in 1986 and is progressing in implementing the eleven selected technologies for 1987. At present, the SITE program staff is reviewing the proposals received from the 1988 solicitation.

INTRODUCTION

The Environmental Protection Agency (EPA) has established a technology research program called the Superfund Innovative Technology Evaluation (SITE)

program. The program was initiated by the Office of Research and Development (ORD) and the Office of Solid Waste and Emergency Response (OSWER) and will evaluate technologies necessary to support the Superfund Amendments and Reauthorization Act of 1986 (SARA)[1]. The 1986 amendments created a comprehensive program for developing and demonstrating alternative and innovative treatment technologies. The terms alternative or innovative treatment technologies are defined in the law to mean those technologies that permanently alter the composition of hazardous wastes through chemical, biological, or physical means so as to significantly destroy, immobilize, or reduce the toxicity and/or volume of the waste. A strategy and program plan was developed and published in December 1986 explaining the SITE program [2]. The SITE program has been discussed at the HMCRI conferences in 1986[3] and 1987[4], and in a report prepared for Congress[5].

The primary goal of the SITE program is to provide an opportunity to demonstrate promising alternative and innovative technologies to treat hazardous wastes.

The SITE program has been designed to accomplish several objectives. Four major objectives are as follows:

1. To identify and remove impediments for the demonstration and future implementation of alternative and innovative treatment technologies.

2. To demonstrate technologies to establish reliable performance data and cost information.

3. To develop procedures and policies that encourage selection of alternative treatment technologies for Superfund site cleanup.

4. To accelerate and promote further development of promising innovative technologies not yet ready for full-scale demonstration.

The demonstration portion of the SITE program represents a unique partnership between EPA and the technology developers. EPA is authorized to enter into contracts, grants, and cooperative agreements to carry out the SITE program. The

developer is primarily responsible for mobilizing and implementing the technology process whereas EPA prepares for the demonstration by selection of the site; writing the necessary work plans; implementing the necessary regulatory requirements; helping with permitting; working with the community; and most specifically, being responsible for a reliable sampling and analysis effort, as well as producing the necessary final reports. Regarding these last two items, a significant responsibility of the SITE program is to produce the best quality data from the demonstration.

The SITE program consists of two separate technology evaluation activities; the first is the demonstration program on which this paper will focus, and the second is the Emerging Technology Program (ETP), which is intended to assist in bringing bench/laboratory-scale innovative technologies to the pilot-scale level.

The ETP will foster the development of technologies that are not yet ready for field demonstration. The goal is to ensure that a steady stream of effective technologies will be ready to be demonstrated, thereby increasing the number of viable alternatives available for hazardous waste cleanups. The emerging technologies are intended to develop innovative technologies for recycling, separating, destroying, immobilizing or reducing concentrations of hazardous waste material, along with technologies for material-handling. Candidate technologies must show promise for commercialization but must not yet be at the field demonstration stage of development. The ETP goal is to assist in successful pilot-scale development. The first solicitation for the ETP was in December 1987. Eighty-four proposals were received in response to the Request for Proposals (RFP).

DEMONSTRATION PROGRAM

The purpose of the demonstration and evaluation of selected technologies is to develop performance, cost-effectiveness, and accurate data so that Superfund decision-makers can make more informed judgments as to the applicability of a

technology to a particular site. The results of the demonstrations should identify the capabilities of the technology, the appropriate type of wastes and media, the operating procedures, and the approximate capital and operating costs. The demonstrations will be carried out at full scale or at a scale that allows valid comparison and direct scale-up to commercial size units. The duration of the demonstration will be determined on a case by case basis but must be of a sufficient time to adequately characterize equipment reliability and operational variabilities.

SITE demonstrations will usually be conducted at actual Superfund uncontrolled hazardous waste sites, state and/or federal, or federally owned sites. Demonstrations may also occur at the developer's facility or EPA's test and evaluation (T&E) facilities. The T&E and developer's facilities could provide for testing of smaller and moderate size units, and wastes would be brought in from actual hazardous waste sites. However, permitting is more of an issue when demonstrations are not done on Superfund sites and may cause a time delay. Demonstrations on Superfund sites will comply with all legally applicable or relevant and appropriate standards (as these terms are defined in Superfund). Permitting will be required at all other demonstration sites.

The funding of the demonstration will be cost-shared between EPA and the developer. Usually the developer will pay the costs to mobilize and operate the equipment or run the process, as well as be responsible for dismantling, decontaminating, and removing the equipment at the end of the demonstration. EPA will be responsible for the costs of site preparation, sampling and analysis, quality assurance and quality control, data evaluation, and report preparation. EPA will assist the developer to obtain whatever permits are required. Normally, there will be no exchange of funds between the Agency and the developer. However, if the technology is very unique, unusually promising, and the developer can demonstrate a lack of financial support by meeting the financial criteria given in the 1988

request for proposals, then EPA will consider bearing a greater proportion of the total project cost.

Two reports will be written when a demonstration is completed. The first report will describe the technology, the demonstration, the sampling and analysis data, and note any problems or points of interest. The second report is called an Application Analysis where the technology will be discussed with respect to its applicability to various waste constituents, waste media, and other sites. The economic aspects of the technology will also be discussed.

Once the reports have been prepared, EPA will undertake an outreach program to provide the results of the demonstration to the Agency, community and, private concerns so that the application of these technologies can be applied to other hazardous waste sites. A technology transfer and technical assistance program will be established.

Since 1986, EPA has solicited requests for proposals three times. In 1986 (SITE-001) twenty-one responses were received, and ten technologies were selected for demonstration. Five were thermal, two extraction, two stabilization and solidification and one biological. The second solicitation (SITE-002) in 1987 received twenty-nine responses. From the twenty-nine proposals, eleven were selected. Three were biological, one chemical, one thermal, five stabilization and solidification, and one extraction. Site selection for these technologies was done in early 1988 and efforts to implement the demonstrations are in progress. The third solicitation (SITE-003) went out in January 1988 and responses were received in March. Review and evaluation of these proposals are currently being performed by the SITE technical evaluation review panel and results should be available in May 1988.

The demonstration process on the SITE-001 1986 selected technologies began in 1987. A description of these technologies and discussions of completed

demonstrations are presented below.

TECHNOLOGIES

ELECTRIC INFRARED FURNACE

This thermal treatment process was developed by Shirco Infrared Systems, Inc. This process uses rows of electrically powered silicon carbide rods to bring the waste to combustion temperatures. Remaining combustibles are destroyed in an afterburner. The full-scale, four-component system can process 100 to 250 tons of waste per day, depending on the waste characteristics. Temperatures in the primary chamber can reach 1850°F and residence time can range from 10 to 90 minutes. Waste moves through the primary furnace on a woven wire mesh belt. Organic materials volatilized in the primary chamber enter a secondary chamber where combustion is completed at temperatures up to 2,300°F and two seconds residence time. Exhaust gases then pass through a venturi scrubber spray tower. Acid vapors are neutralized and an induced draft blower draws cleaned gases from the scrubber into the exhaust stack.

The SITE demonstration took place from July 31 to August 6, 1987 at the Peake Oil Superfund site in Brandon, Florida. Approximately 6,000 cubic yards of waste oil sludge contaminated with polychlorinated biphenyls (PCB's) and lead were incinerated. During the week, the SITE project team worked at three 8-hour trial burns. They conducted extensive sampling, and all operating procedures and conditions were documented. A quality assurance/quality control audit team from EPA's Office of Research and Development performed a sampling audit. A laboratory audit was also done by the same office for the analysis of the samples.

The result of the demonstration showed that the secondary combustion chamber temperature was approximately 1900°F and the Destruction Rate Efficiency (DRE) for PCB was 99.99 percent. At times the unit had difficulty in reaching the 0.08 gr/dscf particulate level. After the scrubber was cleaned and mechanically

adjusted, this level was achieved.

The Peake Oil Shirco unit was a full-scale operation. Another demonstration with a Shirco unit at a pilot-scale level was done in the State of Michigan in Rose Township. The demonstration began on November 3, 1987 and was completed in ten days. The same documentation and sample auditing occurred at this site as well.

The pilot-scale Shirco unit operates at a rate of approximately one ton per day. The Rose Township site is a 20-acre site that contained buried drums of various solvents and paint sludges. These drums had been removed from the site in 1980, however, the soil remaining contained high concentrations of organics, PCB's, and metals, principally lead. In both demonstrations the major focus was to evaluate the reliability of the units in destroying PCB's and to determine if the lead compounds were converted from a soluble to an insoluble form.

SOLIDIFICATION AND STABILIZATION

A solidification/stabilization process was developed by Hazcon, Inc. of Katy, Texas. This process takes contaminated soil, sludge or liquid material and mixes it with a cement material and a proprietary reagent called Chloranan. The Chloranan neutralizes the inhibiting affect that organic contaminants have on the pozzolanic materials. The mixture becomes hardened within 10 to 15 minutes. Hazcon states that the process is applicable to hydrocarbon waste from refining operations, petrochemicals, residue from oil-based paint, solvents and greases and inorganic waste containing heavy metals.

The operation uses standard blending and mixing equipment available from machinery suppliers. A mobile field blending unit is available which can be set up at a site in a few hours. The resulting product can be extruded into drums or forms creating solid blocks, or it can be placed in-situ.

The SITE demonstration for the Hazcon process took place between October 13-16, 1987 at the Douglassville Disposal Superfund site in Union Township near

Douglassville, Pennsylvania. The site is an abandoned oil recovery facility of approximately 50 acres. More than 250,000 cubic yards of soil may be contaminated with a wide variety of pollutants, specifically volatile organics, PCB's, and lead.

Hazcon used the Mobile Field Blending Unit along with cement and water supply trucks. The mobile unit consists of soil and cement holding bins, a Chloranan feed tank, and a blending auger to mix all the components.

The solidified blocks, after setting, were returned to the excavated area where a nonporous plastic liner was placed over the bottom and sides of the hole. Clean fill was placed on top of the liner. Samples were taken from the solidified structure. Samples will also be taken periodically of both the surrounding soil and the block structure during a 5-year monitoring program.

VACUUM EXTRACTION

Terra Vac, Inc. of Dorado, Puerto Rico has developed a process for in-situ vacuum extraction of volatile contaminants from soils and groundwater. The process consists of installing wells in the subsurface unsaturated zone and introducing a negative pressure through the use of vacuum pumps. The air-streams from the wells are extracted and pulled through a separator device and activated carbon for adsorption of the volatile compounds before the vapor is discharged to the atmosphere. The process should provide advantages where excavation of contaminated soils is impractical or very costly. The technology has been applied to a wide range of volatile compounds, as well as organic and chlorinated solvents.

This demonstration began in November 1987 and continued through February 1988 at the Groveland Wells Superfund site in Groveland, Massachusetts. Approximately a 2-acre site containing 2,000 to 3,000 cubic yards of soil is contaminated with volatile organic compounds.

OXYGEN ENRICHED BURNER

American Combustion Technologies, Inc. of Norcross, Georgia, has developed an oxygen-air-fuel burner, the Pyreton™, that can be fitted onto a conventional rotary kiln. The use of oxygen in the burner allows a higher burning temperature which improves the kinetics of waste destruction, allows higher waste throughput, and reduces stack gas volume, i.e., nitrogen. Solids and sludges can be coincinerated when the burners are used in conjunction with rotary kiln furnaces.

The Pyreton™ burner is a proprietary design with advanced fuel injection and mixing to provide quicker ignition and thorough burning of wastes. The technology was demonstrated at EPA's Combustion Research Facility (CRF) at Jefferson, Arkansas. The research rotary kiln was modified to accept the oxygen burner. Soil contaminated with industrial waste from the Stringfellow Acid Pits Superfund site in California was burned. Approximately 5,000 pounds of contaminated soil was treated.

ELECTRIC PYROLYZER

This system, by Westinghouse Environmental Technology Division, is designed for thermal destruction of organic hazardous wastes without combustion. The system operates through rapid transfer of energy to the waste material causing dissociation of the organic molecules into individual atoms. Temperatures can reach 3,250°F. Halogens, metals and other impurities are trapped within a molten bath. Gas residence time can be controlled as necessary to destroy organic materials. Exhaust gases are treated in a water-cooled cyclone baghouse filter, and venturi scrubber.

Westinghouse claims that in addition to destroying organics, the system reduces metals to their elemental state and all inorganic oxides, sulfides, and halides are fixed as liquid silicates. Solids fall into a molten bath which when cooled forms a vitrified material, which should be leach resistant.

PYROPLASMA SYSTEM

Another thermal technology by Westinghouse Environmental Technology Division is the Pyroplasma System. A plasma arc torch produces a thermal plasma with temperatures of more than 9000°F. Mounted on a 48-foot trailer,the unit can process 2 to 3 gallons per minute. Liquids are injected directly into the plasma where the molecules are broken into their atomic states and the atoms then recombine to produce hydrogen, carbon monoxide, nitrogen, hydrogen chloride, particulate carbon, carbon dioxide, ethylene and acetylene. The product gas is scrubbed with caustic soda to neutralize and remove the acid gases and remove particulates.

Westinghouse claims that the pyroplasma system is capable of destroying any pumpable liquid organic waste. The unit is not designed to destroy solids, although it can handle up to 40 percent solids if they are pumpable and can pass through a 200-mesh screen. Heavy metals pass through the system in the scrubber water.

Two demonstrations will take place with this technology--one with the mobile Westinghouse system and a smaller plasma arc unit (1 gallon/minute) designed by Pyrolysis Systems, Inc. This unit is owned by the State of New York and is intended to treat dioxin-contaminated sludge from the Love Canal site.

CIRCULATING FLUIDIZED BED COMBUSTOR

This advanced fluidized bed incinerator was developed by GA Technologies and is now owned by Ogden Environmental Services. The combustor operates at a higher velocity airflow, and produces a much higher combustion efficiency than a conventional fluidized bed. The combustor provides a high turbulent combustion zone with temperatures in the range of 1450° to 2000°F, into which solid or liquid waste feeds can be introduced. Solidified material has a residence time of 30 minutes while gases have a residence of 2 seconds. The unit employs simultaneous limestone injection that captures the acid gases and eliminates the need for a scrubber.

International Waste Technologies (IWT) has a system that drills and blends waste material in place with its patented bonding agent. The process bonds organic and inorganic compounds, creating "macromolecules" which are resistant to acids and other deteriorating factors. The waste forms a solid, crystalline, inorganic polymer in the shape of a vertical column. The method can be installed in-situ, by injecting and mixing chemicals with soils, using a hollow auger. A demonstration is planned at a General Electric site in Hialeah, Florida. About 7,000 cubic yards of PCB contaminated soil is to be treated.

BIOLOGICAL

Detox Industries, Inc. of Sugarland, Texas has a process for the biodegradation of organic contaminants in water, sludge or a soil media. The process involves the accelerated growth of microorganisms and the addition of nutrients or reagents when necessary. Detox feels their process can be done in-situ as well as within reactors. Detox claims that they have adapted microorganisms to biodegrade PCB's, PCP's, creosote, oils, phenolics, and PAH's. Particular naturally-occurring microorganisms are cultivated for accelerated growth and applied to the contaminant which is metabolized into carbon dioxide, water, and cell protoplasm. A demonstration is planned at the United Creosote Superfund site near Houston, Texas for Region VI utilizing a batch reactor. The material to be treated is soil contaminated with wood treating wastes.

EXTRACTION

The Basic Extraction Sludge Technology (B.E.S.T.™) was developed by Resource Conservation Co., in Bellevue, Washington to dewater and deoil contaminated sludges and soils. The process uses differences in chemical miscibility at different temperatures to break waste down into three distinct fractions: 1) discharge water, 2) reusable oil and organics, and 3) dry, oil-free solids. The transportable unit treats solid particles no larger than 1/4 of an inch.

The B.E.S.T. system was shown to be successful in an EPA removal action at a Superfund site in Savannah, Georgia. Based on this test, the system was accepted into the SITE program for a detailed demonstration at a site yet to be determined.

SITE-002 TECHNOLOGIES

SITE-002 technologies went through a site selection process in January 1988, and demonstration plans for these technologies are now being prepared. Demonstrations will begin late in 1988. These technologies are as follows:

BIOLOGICAL

Air Products and Chemicals, Inc. of Allentown, Pennsylvania has a process that was originally developed by Dorr-Oliver. The process is an aerobic biological treatment of wastewater enhanced in a fixed-film fluidized bed. The fixed film is supported on either an inert medium (sand) or activated carbon. Pure oxygen is dissolved in the influent stream in a controlled fashion to ensure that no excess oxygen is released at the top of the reactor. The use of pure oxygen eliminates the need for excess aeration and reduces the possibility of emitting volatile organic compounds (VOC) from the treatment process. The system consists of a reactor unit, an oxygen supply system, a biomass separating device, pumps, a recycle tank, and mechanical controls. An off-gas carbon adsorption unit is available, if needed.

This process treats wastewaters containing soluble biodegradable organic compounds including VOC's. This process does not remove solids or inorganics. High concentrations of heavy metals, PCB's and other biologically inhibitory constituents require pretreatment.

Zimpro Environmental Control Systems of Rothschild, Wisconsin has a process which combines biological treatment, powdered activated carbon treatment (PACT™), and wet air oxidation. Powdered activated carbon is added to the aeration basin, and adsorbable organic compounds are retained on the carbon with the sludge solids.

Adsorbed compounds are recycled to the aeration basin with the carbon and activated sludge. This provides longer retention time in the treatment system for improved biodegradation of some organic compounds. Absorbable inorganics are also retained on the carbon, minimizing their impact on the biological process. A polymer is added to improve solids capture in the clarifier. Excess solids are removed from the clarifier underflow. The spent carbon may be regenerated by wet air oxidation and recycled into the system. Upon completion of the PACT process, high temperature wet air oxidation may be used to treat the remaining sludge and carbon.

Organic wastewaters ranging from highly contaminated leachate to low-strength industrial wastewater can be treated by the PACT process. High-strength industrial wastewater will require pretreatment. Waste streams containing significant concentrations of heavy metals are pretreated to precipitate the metal constituents. Pretreatment is also required for waste streams with high suspended solids.

MoTec, Inc. of Mt. Juliet, Tennessee has a process known as Liquid Solids Contact Digestion (LSCD) that biologically treats liquids, soils and sludges contaminated with organic compounds. After treatment in the primary digestion tanks or inground reactors, where the waste undergoes aerobic biological treatment, the mixture goes through further steps in a polishing reactor to reduce the waste concentration. Sludge from the polishing reactors is dried in tanks or inground reactors constructed at the site. MoTec states that sludge volume is reduced by 30 to 60 percent by this process, depending on the sludge TOC and water content.

MoTec has had some experience in treating the wood preserving wastes of pentachlorophenol at 89,000 ppm, and creosote at 500,000 ppm. Both concentrations were reduced by more than 99 percent during treatment. Full-scale units have been developed for the following organic wastes: halogenated organic compounds,

nonhalogenated organic compounds (e.g., phenols, PAH's), pesticides, and volatile organic compounds (VOCs).

The process can tolerate some metals, depending on the type, however heavy metals can inhibit microbial metabolism.

EXTRACTION

C.F. Systems Corporation of Cambridge, Massachusetts has a solvent extraction with liquid gas treatment process. Liquified gases (carbon dioxide or propane) at high pressure are used to extract oils and organic solvents from wastewater and sludge in a continuous process. Waste is extracted with the fluidized gas in high pressure reactors. The high pressure liquifies the gases, and the organic contaminants dissolve into the liquified gas. When the extraction is complete, the liquids are separated, and the gases are evaporated from the organic liquid contaminants by reducing the pressure. The evaporated gases are recompressed, condensed, and recycled to the extraction reactor. Energy is conserved by using the heat generated by gas compression and condensation to heat the gas evaporation step.

Two byproducts are produced from the process, one an organic-liquid extract and the second a feed material residue. The concentrated organic liquid is composed of the organic compounds extracted from the waste. The residue contains the nonextracted material, which is mostly water and solids. Wastes treated involve a wide range of organic compounds. Materials contaminated with heavy metals or inorganic compounds are not appropriate for this technology.

THERMAL

Retech, Inc., of Ukiah, California has a process which destroys organic wastes and reduces the volume of both organic and inorganic wastes. Solid and/or liquid organic wastes are fed to a rotating reservoir within a centrifugal reactor. Wastes are indirectly heated by electrical conductance from a plasma torch. High temperatures of 2,000°F are achieved during the volatilization of liquid components

of the waste, and a high destruction efficiency is achieved on hard to burn wastes. The high temperature reduces the organic constituents to carbon monoxide, hydrogen, and hydrochloric acid, and in some cases to carbon dioxide and water. The volatilized components are captured and treated in a gas scrubber unit.

Metals and small amounts of solid carbon remain in the vitrified combustion residue. Constituents are fixed in the vitrified residue during the cooling process when the residue is removed from the reactor. The residue can be recycled and treated if concentrations of hazardous components are present.

The system consists of a centrifugal reactor with an internal rotating reservoir that is heated by a plasma torch. The system also includes a screw feeder, holding tanks, and a gas scrubbing system. The technology is applicable to organic and inorganic wastes.

ION EXCHANGE

Sanitech, Inc. of Twinsburg, Ohio has a process where metal-bearing wastewater is treated by filtration and ion-exchange. The wastewater is passed through a bed of silica particles coated with a selective ion-exchange compound which removes the metals from the waste stream. The metals are then recovered by acid regeneration of the ion-exchange compound. The ion-exchange unit is made up of two beds containing 100 liters (smaller unit) or 200 liters (larger unit) of ion-exchange compound, prefilters, a regeneration subsystem, and a control module. A prefilter is not included in the larger unit.

This process treats industrial wastewater, contaminated groundwater and surface waters. Sludges and contaminated soil are not treated by this process.

SOLIDIFICATION/STABILIZATION

Soliditech, Inc. of Houston, Texas has a stabilization/solidification process which mixes waste constituents with pozzolanic agents, water, and liquid reagents including URRICHEM. Microblending occurs in the mixing process and

microencapsulation occurs partly by cross-linking organic and inorganic particles through a five-phase cementation process. The final product is a pasty material that is suitable for casting into solid shapes. Soliditech indicates that the solidified waste exhibits low leaching potential and can achieve an unconfined compressive strength of 5,500 psi. According to Soliditech, the waste volume from processing can vary from a 20 percent decrease to a 30 percent increase, depending on waste characteristics.

The system consists of a 13-cubic-yard ribbon type mixer, a pozzolanic storage silo, reagent holding tanks or hoppers, and multiple pumps. A shredder and a flash mixer are also available. Treatment includes a wide range of organic and inorganic contaminated liquids, slurries, sludges or soils.

WasteChem Corporation of Paramus, New Jersey, has a Mobile Volume Reduction and Solidification (VRS) System to decontaminate and solidify liquids, sludges, and soils. A fluidized waste stream and asphalt are fed into an extruder/evaporator to be mixed together. The heated extruder/evaporator uses co-rotating self-cleaning screw elements to mix and convey the materials and to evaporate free water and volatile organic compounds (VOCs).

The asphalt and waste mixture hardens to form a free standing monolith when cooled. Usually the material is placed in 55-gallon drums. WasteChem indicates that heavy metals and nonvolatilized organic constituents are encapsulated in the solidified mixture.

A mobile system is equipped with a waste batch tank, asphalt storage tank and recirculation system, extruder/evaporator, devolatilization domes, condensor, carbon adsorption, and HEPA filters. Organic and metal-bearing wastes are treated by this process. Wastes containing water and/or VOC's are particularly suitable because of the evaporation and subsequent volume reduction.

Chemfix Technologies, Inc. of Metairie, Louisiana has a process that stabilizes high-molecular-weight organic and inorganic material. The process uses soluble silicate reagents and silicate setting agents in contaminated soil or sludge. Three classes of reactions occur: 1) soluble silicates react with cations in the waste mixture to form silicates; 2) the silicious setting agents react with the remaining soluble silicates to produce a gel structure; and 3) hydrolysis, hydration, and neutralization occur to stabilize the final product. For the treatment of certain organic constituents and certain heavy metals, an additive is introduced with the silicate setting agent. Chemfix states that the volume may increase as much as 20 percent.

The final treated material is an inert clay-like material with high total alkalinity and low permeability. In some instances the product has been used for lining or capping landfills. The process is applicable to sludge and contaminated soil containing nonvolatile organics (e.g., PCB's, creosote), and heavy metals. The process can also treat the ash remaining from incineration of wastes that contain both organics and metals.

Battelle Pacific Northwest Laboratories of Richland, Washington has an In-situ Vitrification (ISV) process which thermally destroys organic constituents and converts contaminated soil or sludge into a chemically inert, stable glass and crystalline product. The ISV technology is based on the concept of joule-heating to electrically melt the soil or sludge at temperatures ranging from 1600 to 2000°C which act to destroy organic pollutants by pyrolysis. Both the airborne organic and inorganic combustion byproducts are collected in a negatively pressurized hood, and an off-gas treatment system removes particulates and other pollutants of concern.

The system is to be mounted on two semitrailers. Four electrodes are driven into the soil or sludge and a current is applied. One setting is approximately 25 ft. x 25 ft. x 50 ft. Vitrification takes place over seven to ten days. The

system is then moved to another setting. Upon completion of the vitrification at the site, the vitrified mass is left to cool for several months to a year.

The ISV process can be used to destroy or volatilize organics and/or immobilize inorganics. The sludges must contain a sufficient amount of glass forming material to produce a molten mass.

Separation and Recovery Systems, Inc., of Irvine, California has a lime-based technology with additive chemicals that are specifically prepared to solidify and stabilize hazardous waste materials. Primarily, the SRS/EIF process utilizes a simple physico-chemical reaction system, utilizing lime as a base material, which transforms the sludge material and associated contaminated solids and liquids into a dry pulverized material. The resultant product resembles brown soil, which can be handled like soil, and can be compacted to a high degree. The lime characteristics, along with the chemical catalysts control the rate of reaction. The chemicals significantly increase the effective surface area of the waste material. The volume of the product is typically 30 percent greater than the untreated waste. The reactions that occur are exothermic. The temperature of the mixture rises to around 100°C during a twenty minute period. The mixture cools shortly afterwards close to ambient temperature. Some steam evolves from the mixture.

The technology is effective on acidic sludges containing at least three percent hydrocarbons (typical of sludges produced by remanufacturing lube oils). Claims are made that metals are also immobilized, but the process tolerates only low levels of mercury and moderate levels of lead.

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